Occidental Chemical Corporation

OFF-SITE INVESTIGATION (OSI) PROGRAM PHASE 2 REPORT

Buffalo Avenue Plant
Module III - Corrective Action and
Waste Minimization Requirements
DEC Permit Number 90-86-0707

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ARC	American Ref-Fuel Company of Niagara Falls
BNAs	Base/Neutral Acid Extractables
BTOR	Below Top of Rock
EBDTS	Energy Boulevard Drain Tile System
EFW	Energy From Waste (renamed RRF)
GZA	GZA GeoEnvironmental of New York
HCCH	Hexachlorocyclohexane
ISSS	Iroquois Street Sanitary Sewer
NAPL	Non-Aqueous Phase Liquids
NYPA	New York Power Authority
OSI	Off-Site Investigation
OxyChem	Occidental Chemical Corporation
Plant	OxyChem's Buffalo Avenue Plant
PP	Priority Pollutant
RCRA	Resource Conservation and Recovery Act
RRF	Resource Recovery Facility (formerly EFW)
SDCP	Supplemental Data Collection Program
SSI	Site Specific Indicators
State	New York State Department of Environmental Conservation
TCL	Target Compound List
UDG	United Development Group
VOC	Volatile Organic Compounds

1.0 INTRODUCTION

On August 19, 1992, Occidental Chemical Corporation (OxyChem) submitted to the New York State Department of Environmental Conservation (State) the report entitled "Off-Site Investigation (OSI) Summary Report" (hereafter: Summary Report) which described the investigation completed in the areas to the north and west of OxyChem's Buffalo Avenue Plant (Plant) in Niagara Falls, New York. Following discussions between the State and OxyChem, it was agreed that some additional geological and groundwater chemical data were required to finalize the OSI program. Consequently, a Phase 2 of the OSI was developed and implemented.

This report has been prepared to present the results of the OSI - Phase 2 bedrock and overburden investigation conducted.

This report concludes the OSI program. The database now sufficiently characterizes the bedrock and overburden off-Site conditions to allow development of corrective measures for the Plant boundary areas.

The OSI program was undertaken as part of the Buffalo Avenue Plant Corrective Action Program, with the following purpose and scope of investigation:

- To determine the magnitude and extent of Site-related chemical presence in the overburden and bedrock groundwater regimes in the off-Site areas which are downgradient of those areas along the Plant boundary that exhibit the highest chemical concentrations; and
- To evaluate the extent to which the New York Power Authority (NYPA) Power Conduit drains, the Falls Street Tunnel/South Side Interceptor Sewer and the Energy Boulevard Drain Tile System (EBDTS) influence the off-Site migration of chemicals in the groundwater.

In addition to the Phase 2 data, bedrock groundwater analytical results documented in the report entitled "Environmental Study

Data Report, September 1993", prepared by GZA GeoEnvironmental of New York (GZA) on behalf of American Ref-Fuel Company of Niagara Falls (ARC) at the former OxyChem Energy From Waste Facility (EFW) and non-contiguous parcels has been incorporated into this OSI database. The GZA/ARC bedrock groundwater analytical results are presented in the report entitled "Bedrock Groundwater Analytical Results American Ref-Fuel Resource Recovery Facility, November 1993", which is included in this report as Appendix E. The EFW was renamed the Resource Recovery Facility (RRF) by ARC.

1.1 BACKGROUND

1.1.1 Study Location

The OSI study area is located adjacent to the north and west boundaries of the Plant and includes lands east of the NYPA Power Conduits, south of Royal Avenue and west of 53rd Street. This area is predominantly industrial and includes several acres of vacant land. Figure 1.1. shows the OSI study area and property ownership within the study area.

1.1.2 OSI Summary

During Phase 1 of the OSI, nine overburden monitoring wells (OW553 through OW561) and 11 bedrock monitoring wells (OW649 through OW659) were installed to determine the magnitude and extent of Site-related chemical migration to the off-Site areas north and west of the Plant in both the overburden and bedrock groundwater regimes. The locations of these 20 wells are shown on Figure 1.2.

There are numerous man-made structures which influence groundwater flow in the overburden and bedrock within the OSI study area. These structures include the NYPA Power Conduits, the Falls Street Tunnel and Southside Interceptor System, the Iroquois Street and

47th Street Sanitary Sewers, the EBDTS, various underground utilities, building and structure foundations and foundation drainage systems. These major hydraulic influences are shown on Figure 1.3.

Two rounds of chemical sampling were completed during Phase 1 of the OSI. Samples were collected from the 21 OSI wells, five existing off-Site wells (MW88-6A and MW88-68 at Frontier Chemical and 7B, 23B and 23C installed by Dupont), the EBDTS and the RRF foundation drainage system. All samples were analyzed for Site Specific Indicator (SSI) parameters.

- Overburden Conditions

The results of the Phase 1 OSI showed that the overburden groundwater flow direction was southward in areas north of the Plant, and westward in the vicinity of the NYPA Power Conduits.

Two areas of off-Site overburden groundwater chemical presence were identified to be present. These two areas were centered around wells OW554 (85 and 1500 µg/L of total SSI organics for Round 1/Round 2) and OW559 (220 and 45 µg/L). All other overburden wells were less than 45 µg/L of total SSI organics for each of the two sampling rounds.

- Bedrock Conditions

The Phase 1 OSI showed bedrock groundwater flow direction for the D-Zone was generally north-northwest toward the intersection of the Falls Street Tunnel and the NYPA Power Conduits. The C-Zone flowed in the same general direction, while the B-Zone groundwater flowed in a north-northeast direction.

Bedrock groundwater chemistry in the D-Zone showed a consistent pattern of chemical distribution through the off-Site area north of the Plant. Results from the first line of wells located 1,000 feet north of the Plant boundary (OW650, OW651, OW652 and OW653) showed chemical concentrations significantly lower than those observed in wells along the

Plant boundary (OW403D, OW404D, OW405D, OW406D and OW407D). Samples from the OW654D and OW655D wells along Royal Avenue (and 500 feet further north of the first line of wells) showed chemical concentrations which were greater than those observed in the first line of wells. Also, well MW88-6B, located on the Frontier Chemical property north of Royal Avenue, showed elevated chemical concentrations; higher than those observed in the first line of wells. The C-Zone wells showed the same general pattern, with concentrations in the first line C-Zone wells being lower than the concentrations in the wells along the Plant boundary and the OW654 C-Zone well to the north. The only B-Zone well to the north of the Plant (OW654B) showed a total SSI organic concentration significantly lower than concentrations observed along the Plant boundary.

Non-Aqueous Phase Liquids (NAPL) were not observed during bedrock well installation, except for a trace NAPL staining on the rock core from OW650 which is located to the west of the NYPA Power Conduits. NAPL was observed in OW654D during well development. Trace NAPL was observed in the overburden during installation of OW554. As NAPL migrates by gravity, it is believed that the NAPL presence at OW654D did not migrate northward from the Plant as the bedrock bedding planes dip southerly toward the river making northward NAPL migration from the Plant unlikely over such a long distance. Additionally, OW652D, which is located between OW654D and the Plant, did not have any NAPL presence.

In conclusion, the OSI Summary Report indicated that the Plant was not contributing to the elevated groundwater chemical presence observed in the vicinity of Royal Avenue. The results suggested that an off-Site source of chemical presence existed in the vicinity of Royal Avenue. In an effort to confirm these conclusions, the additional OSI Phase 2 investigation described within was completed. Details on the OSI Phase 1 are contained in the Summary Report, August 1992.

2.0 OSI - PHASE 2 PROGRAM SUMMARY

The Phase 2 components of the OSI were:

i) installation and hydraulic testing of three bedrock well nests (OW657, OW658, OW659) along the first line of wells (approximately 100 feet) north of the Plant boundary.

ii) installation and hydraulic testing of intermediate bedrock wells (C-Zone and B-Zone) at two locations where Phase 1 D-Zone bedrock wells exist (OW652, OW653);

iii) investigation of the Iroquois Street Sanitary Sewer (ISSS) bedding as a potential NAPL migration route (BH11D-92);

iv) chemical and hydraulic monitoring of the Phase 2 bedrock wells and selected existing bedrock wells; and

v) chemical and hydraulic monitoring of appropriate OxyChem overburden wells and selected United Development Group (UDG) overburden wells adjacent to the northeast boundary of the Plant.

The OSI Phase 2 investigation, which is described in this report, has been conducted in compliance with the following documents:

- Off-Site Investigation Work Plan
  Buffalo Avenue Plant
  February 1991;

- Appendix A
  Site Operations Plan (SOP)
  Buffalo Avenue Plant
  Supplemental Data Collection Program (SDCP)
  March 1988;

- Appendix B
  Environmental Health and Safety Plan
  Buffalo Avenue Plant
  Supplemental Data Collection Program (SDCP)
  March 1988; and

- Appendix C
  Chemical Sampling and Quality Assurance Plan
  Buffalo Avenue Plant
  Supplemental Data Collection Program (SDCP)
  March 1988.

The following subsections discuss the OSI Phase 2 investigations completed and the protocols/procedures utilized.

2.1 BEDROCK WELL INSTALLATIONS

2.1.1 Bedrock Well Locations

The locations of the Phase 2 off-Site bedrock wells installed during the OSI program are shown on Figure 2.1. A total of 13 bedrock wells were installed in Phase 2 at five well nests as follows:

OW652	B-Zone Monitor C-Zone Monitor (D-Zone Monitor completed in Phase 1)
OW653	B-Zone Monitor C-Zone Monitor (D-Zone Monitor completed in Phase 1)
OW657	B-Zone Monitor C-Zone Monitor D-Zone Monitor
OW658	B-Zone Monitor C-Zone Monitor D-Zone Monitor

OW659 B-Zone Monitor
C-Zone Monitor
D-Zone Monitor

These wells were installed to supplement the existing data regarding:

a) groundwater flow directions in the bedrock,
b) the nature and distribution of chemicals in the bedrock groundwater,
c) the nature and distribution of NAPL in the bedrock, and
d) the transmissivity of the stratigraphic formations of the Lockport Group.

2.1.2 Bedrock Well Installation Procedures and Protocols

The following subsections describe the installation procedures and the determination of the monitoring intervals installed at each bedrock well nest. A typical bedrock well nest is presented on Figure 2.2.

- Overburden Casing Installation

Permanent steel casings were installed through the overburden material to prevent the vertical migration of chemicals from the overburden into the bedrock. These casings were installed as follows:

a) Continuous split spoon samples were collected in the overburden regime from the top of the ground surface to the top of bedrock in advance of augering. Soil samples were collected, recorded and placed into Plant storage for a geologic record. Soil samples were collected at only one location per well nest. At the well nests where D-Wells were already installed (OW652, OW653) and the overburden stratigraphy was already logged, no split spoon sampling was performed.

b) Twelve-inch outside diameter augers were advanced through the overburden to refusal (six± inches below the bedrock/overburden interface) to generate a notch in the bedrock for the overburden casing at each location.

c) A clean six-inch inside diameter steel casing was set inside the augers and permanently grouted into the bedrock notch. Grout placement was performed by filling the overburden borehole with grout and immersing the 6-inch steel casing, with the lower end plugged off, in the grout. The casing was pushed securely into the bedrock notch using the drill rig.

- <u>Hydrostatic Testing of Overburden Casing</u>

a) After the grout had set, the grout within the six-inch diameter casing was removed to the bottom of the overburden casing/bedrock interface.

b) The casing was filled with potable water and water loss over a 25-minute period was measured. If a water level drop was observed, an allowable water loss was calculated and compared to the actual water loss. No casing installations during the Phase 2 activities required regrouting as a result of failure of the grout seals.

- <u>Bedrock Coring and Injection Testing</u>

Bedrock coring and injection testing of the bedrock were first completed to the base of the deepest well of each well nest. The typical bedrock coring and testing procedures used are described in the following paragraphs.

At each bedrock well nest (i.e. OW657, OW658 and OW659), coring continued until the top of the Gasport Formation was encountered. Water returns during coring were estimated to determine water loss. The return water was also observed for NAPL presence. NAPL was not observed at any of the installed wells. After coring to the top of the Gasport formation, the bedrock was tested using a double packer injection test assembly which permitted testing of 15±-foot intervals. Typically, testing was performed from the bottom of the corehole to the bottom of the overburden casing.

All rock core collected from each well nest was geologically logged, photographed and placed in storage at the Plant for future reference.

The B and C-Zone wells in each nest were drilled and completed to the depths determined using the injection test data which identified the appropriate waterbearing intervals to be monitored. These wells were installed by drilling a six-inch borehole to the top of the bedrock monitoring interval. A four-inch inside diameter steel casing was grouted in place and the grout was allowed to set for 24 hours before drilling continued. The monitoring interval was cored to a four-inch diameter.

The initial well drilled at each well nest was grouted back through the intermediate bedrock intervals (B and C-Zone) to become the shallow (D-Zone) well.

At locations OW652 and OW653, where intermediate B and C-Zone wells were installed adjacent to an existing D-Zone well, a six-inch borehole was drilled and a four-inch casing was installed to just below the existing D-Zone monitoring interval. Coring from the bottom of the four-inch casing to the top of the Gasport formation and injection testing were performed. After the B and C-Zone monitoring intervals were selected, this initial well was grouted back to become the C-Zone Monitor and the last well was installed as the B-Zone Monitor.

Details on the completed wells in each nest, including bedrock logs are included in Appendix A.

- Injection Testing

The injection test results are summarized in Appendix B - Injection Test Results. Injection testing during the drilling of the deepest bedrock well at each well nest was completed in the following manner:

a) A double-packer test assembly (see Figure 2.3) was used for all tested intervals. The bottom interval was tested using the double-packer assembly with only the upper packer inflated. This resulted in a tested interval of approximately 20 feet for the lowest test while all other test intervals were approximately 15 feet.

b) A typical test consisted of four to five flow steps per interval. In some instances, due to equipment problems or injection pressure restrictions, testing at only three pressure steps was performed.

c) A typical test proceeded as follows:

1. The assembly was lowered into the open borehole to the appropriate depth.

2. A static reading of the water pressure in the borehole was recorded and compared to a calculated value for the transducer depth. This comparison was to calibrate the transducer operation.

3. If the transducer was functioning correctly, the packer(s) were inflated, the interval was allowed to equilibrate, and the pressure (P_o) of the water (measured in psi) in the borehole between the packers was recorded.

4. Each pressure step value (P_i) is calculated using P_o plus increments of 1/5 of the hydrofracture value in psi which is calculated as P_{max} = 0.7 x (thickness in feet of overburden and bedrock above top packer). Water was then pumped into the monitored interval at a flow rate of 5 gallons per minute (gpm), 10 gpm, 15 gpm and 20 gpm. If these flow rates caused the downhole borehole pressure to exceed the calculated P_x value for that step, the flow rate was reduced for that step until a downhole pressure close to P_x was obtained. The test was then run at the appropriate flow rate.

5. For each minute during the test, the water flow rate in gpm and the downhole pressure (psi) were recorded. Each step of the test was run for a minimum of ten stable downhole readings or a maximum of 20 minutes. The line pressure and the temperature of the water were periodically recorded.

6. After completing the pressure steps, the test was terminated and the packer was raised fifteen feet to begin the test in the next borehole interval.

7. The results of these injection tests were used to estimate the hydraulic conductivities of the zones being tested and to determine the intervals to be monitored by each well in a bedrock well nest.

- Well Development

Development was performed in accordance with Section 8.4 of Appendix A of the SDCP.

Bedrock well development was considered complete after 10 well volumes were removed and observed sediment presence was minimal. Groundwater pH and specific conductance were measured for each well volume removed.

At OW653B, after removal of 16 well volumes (990 gallons) the water was still cloudy with a high pH and specific conductance. The well was re-developed the next day with periodic surging of the groundwater in the well. The water cleared and pH dropped rapidly. Stability was achieved after removal of seven well volumes (455 gallons). OW653C went dry during development and was pumped dry three times over two consecutive days. Well OW659D was developed on an intermittent basis over three hours because of limited water availability. The required 10 well volumes were removed and stability of pH and specific conductance was achieved.

2.1.3 Selection of Bedrock Monitoring Intervals

The wells in each bedrock well nest were installed in accordance with Section 8.2 of Appendix A of the SDCP.

a) Installation of A-Zone wells was not required during the OSI. The A-Zone extends from the mid-section of the Gasport to the top of the Rochester Shale.

b) One well to monitor the upper bedrock interval which usually included the upper 40 to 50 feet of bedrock. This well was designated the D-Zone well in each nest.

c) Two wells to monitor all of the waterbearing zones between the A-Zone and the D-Zone well based on the following guidelines:

   i) One well, designated the C-Zone well, to monitor the interval from the bottom of the upper bedrock well installed as the D-Zone well to the top of the most significant non-waterbearing zone, if any, above the Gasport.

   ii) One well designated the B-Zone well, to monitor the interval from the bottom of the non-waterbearing zone identified in the C-Zone well description above, to the top of the Gasport.

   iii) If no non-waterbearing zone was located between the bottom of the upper weathered zone and the top of the Gasport, each of the two wells were installed to monitor an equal portion of this bedrock interval.

The bedrock monitoring intervals for the OW652 and OW653 bedrock nests were determined based on injection tests completed at the OW652 and OW653 C-Zone wells as the D-Zone well at each location was installed previously during the Phase 1 of the OSI.

The bedrock monitoring intervals for the OW657, OW658 and OW659 bedrock well nests were determined based on injection testing completed at OW657D, OW658D and OW659D respectively. The injection test results are presented in Appendix B. The selection of monitoring intervals was reviewed and approved by the State prior to the installation of the remaining wells in each nest.

2.1.4 Stratigraphy and Instrumentation

A summary of the overburden/bedrock stratigraphic unit thickness is presented in Section 3.3. Details on the completion of the Phase 2 bedrock wells, including the well depths, casing depths and the monitoring intervals are contained in Appendix C. The Stratigraphic and Instrumentation Logs describing the stratigraphy of each well nest, are presented in Appendix A.

Bedrock Well Completion/Grouting Summary

At OW652 and OW653, the C-Zone well was drilled to the top of the Gasport Formation. The injection tests were completed on these wells and the appropriate monitoring intervals selected. The C-Zone well was filled with grout from the top of the Gasport to the bottom of the proposed C-Zone well monitoring interval. At OW652, 31 gallons of grout was added in two lifts. Grout came up to 91.0 feet BGS. At OW653, 37 gallons of grout was added in two lifts. Grout came up to 96.0 feet BGS.

At OW657, OW658 and OW659, the D-Zone well was drilled to the top of the Gasport Formation, injection tested and grouted back to become the shallow monitor. At OW657D, 78 gallons of grout was added in three lifts, resulting in a grout level of 94.5 feet BGS. At OW658, 44.5 gallons of grout was added and the grout level rose to 65.0 feet BGS. At OW659, 78 gallons of grout was added and the grout came up to 63.5 feet. On March 29, 1993 after adding grout to OW659D, a grout level of 39.0 feet was measured in the borehole. Since the grout was set too high, the grout was reamed out. After breaking through a small bridge of grout, the hole was open to 63.5 feet BGS. During development of OW659D, the well was pumped dry after 40 gallons (1.5 calculated well volumes) were removed. Well recovery of about 0.7 gallons per minute was measured. It was decided to ream this hole to 6-inch diameter in an attempt to remove any rock which might have been coated with grout. This was done to a depth of 64.0 feet BGS on March 30, 1993. The well was pumped dry on March 31, 1993, and a recovery of about 1.0 gallon per minute was observed. The required 10 well volumes were removed by pumping intermittently, and stable groundwater pH and specific conductance were achieved.

2.1.5 Natural Gas Presence

Natural gas was not encountered during the drilling of any of the bedrock wells.

2.2 IROQUOIS STREET SANITARY SEWER BEDDING INVESTIGATION

A number of borings were installed into the sewer bedding between the Plant and well nest OW654 to evaluate the possibility that the ISSS bedding was providing a preferential route for NAPL migration from the Plant toward OW654. The locations, procedures and sampling performed are described in the following subsections.

2.2.1 Sanitary Sewer Details

An inquiry was made to the City of Niagara Falls regarding the ISSS and its construction (specifically bedding components and piping materials). Plan #309 - Sewer Contract - Sheet No. 3 was acquired and reviewed. The following information has been obtained from Plan #309 and verbal discussions with the City Engineering Department.